94. With respect to claim limitation 8(f), Mr. Muller testified that the ***function*** of IGV position in the APS 3200 was to "tell the surge control system when … it is operating in high flow, and when it is operating in low flow." (Feb. 7, 2001 Trial Tr. 668:22-669:7) Mr. Muller described the ***way*** for achieving this function as generating "the actual control signal for the bleed control valve." (*Id.* at 669:8-22) The ***result*** was that IGV position "is used in the control of the surge control system." (*Id.* at 669:23-670:2)

95. With respect to limitation 4(d), Mr. Muller testified that the ***function*** of IGV position in the APS 3200 was to "establish if the APS 3200 is operating under a high flow condition or a low flow condition." (Feb. 7, 2001 Trial Tr. 693:11-17) The ***way*** was to adjust the relationship according to the IGV position. (*Id.* at 693:18-694:5) The ***result*** was to "allow the surge control system to properly operate … when it is operating in an area where surge is possible" and to "help in determining when it's in the high flow regime where no surge is possible." (*Id.* at 694:6-21)

96. In Mr. Muller's testimony attempting to link the use of IGV position in the APS 3200 surge control system as an equivalent to the IGV limitation, he made no mention of the inverted-V/double solution characteristic. (Feb. 7, 2001 Trial Tr. 668-70, 688-94)

97. In response, HSC's technical expert Francis Shinskey testified that the APS 3200 did not infringe the asserted claims and that the use of IGV position in the APS 3200 was not equivalent to the IGV limitation. (Feb. 12, 2001 Trial Tr. 1396-1423) In particular, Mr. Shinskey explained that IGV position is used in the APS 3200 "based on the unique characteristic of the DELPQP measurement" resulting in a "double value function." (*Id.* at 1382:5-1384:25) Mr. Shinskey noted that the Honeywell patents-at-issue contain "no discussion" of a "high flow versus a low-flow mode of operation or any means used to protect

against the double valued function interfering with surge control." (*Id.* at 1383:17-1384:2) On that basis, Mr. Shinskey opined that the APS 3200 use of IGV position is not equivalent to the IGV limitation in the Honeywell patents. (*Id.* at 1400:2-1401:17)

98. During closing arguments, Honeywell's lead trial counsel argued that the APS 3200 infringed under the doctrine of equivalents because the "flow-related parameter and the surge set point are functions and related to the inlet guide vane position" and that "Delta P over P or DELPQP is related to inlet guide vane position." (Feb. 16, 2001 Trial Tr. 2549:6-12; 2554:16-23)

99. The jury accepted Honeywell's arguments and found that the APS 3200 infringed the asserted claims under the doctrine of equivalents. (D.I. 264)

C. JMOL Motions

100. Following the jury verdict, HSC moved for judgment as a matter of law that, among other things, Honeywell had not met its burden of establishing infringement under the doctrine of equivalents. (D.I. 270) HSC relied upon Mr. Shinskey's testimony as establishing that the use of IGV position in the APS 3200 to address the "double solution" behavior in the APS 3200 was different than – and not equivalent to – the IGV limitation in the asserted claims. (*Id.* at 7-8)

101. Honeywell responded by arguing that the "inlet guide vane played substantially the same role" in both the APS 3200 and the patents. (Honeywell Opposition Brief at 4, D.I. 285) In particular, Honeywell argued that it "introduced evidence that the flow-related parameter used by the APS 3200 surge control system, DELPQP, was a direct function of the inlet guide vane position." (*Id.* at 5) Honeywell stated that the "evidence established that the APS 3200 surge control system does use inlet guide vane position for the role of adjusting the value of the DELPQP parameter." (*Id.*) Honeywell referenced its counsel's closing argument

which "read and discussed Sundstrand's admissions that DELPQP was related to inlet guide vane position." (*Id.* at 20-21)

102. Honeywell's brief made no mention of the use of IGV position to address the double-solution characteristic as being the equivalent to the IGV limitations.

103. Honeywell argued that HSC's defense at trial "relied principally on a series of outright misstatements of fact by its expert witness, Francis Shinskey, which he was forced to recant on cross-examination. This defense lacked all credibility, and the jury was certainly entitled to draw adverse inferences from it regarding the strength of Sundstrand's non-infringement position." (*Id.* at 10)

104. The Court denied HSC's motion. *Honeywell,* 166 F. Supp. 2d 1008. On the doctrine of equivalents issue, the Court found that "Honeywell set forth competent evidence from which a jury could reasonably conclude that the way the APS 3200 uses inlet guide vane position is insubstantially different from the way inlet guide vane position is used in the patent claims. For example, Honeywell introduced evidence at trial from which a jury could conclude that the flow-related parameter used by the APS 3200, DELPQP, was a direct function of inlet guide vane position." *Id.* at 1021.

105. The Court cited Mr. Muller's testimony that "as the IGV position changes, it changes the flow, which changes the value of pressure, divided by the pressure, which generates DELPQP which is a function of, in the end, the change in the IGV position." *Id.* at 1022 (citing Feb. 7, 2001 Trial Tr. 709:17-22).

D. Appeal

106. On appeal, HSC again challenged the sufficiency of the evidence supporting the finding of infringement under the doctrine of equivalents. (HSC 1/28/02 Appellate Brief) HSC argued that the APS "3200 relies on the input of IGV position for a completely different

purpose" than the Honeywell patents. (*Id.* at 31) HSC argued that while the patents seek to use IGV position to "adjust[] the minimum airflow to be maintained to prevent surge," the APS 3200 uses IGV position to "deal with the unreliability of the 3200's unusual flow parameter in extreme high flow circumstances by detecting that condition" and "blocking the normal control signals." (*Id.* at 34-37)

107. Honeywell argued that it had presented sufficient evidence to support the jury verdict of infringement under the doctrine of equivalents. (Honeywell 3/22/02 Appellate Reply Brief) As to claim limitation 4(d), Honeywell contended that there is "substantial evidence from both parties' experts that the function, way and result of IGV position in the APS 3200 mirrors the function, way and result of IGV position in claim limitation 4(d)." (*Id.* at 23) In particular, Honeywell stated that the APS 3200 "measures the position of the IGVs as part of surge control" and uses IGV position to "efficiently to control surge despite changes in the IGV position." (*Id.* at 23-24)

108. As to claim limitations 8(f) and 19(g), Honeywell argued that the APS 3200 "incorporat[ed] the position of the IGV's into the surge control system" by using IGV position to "adjust the 'equivalent' high-flow/low-flow set point of the control system," and as a result, "the APS 3200 efficiently controls surge despite changes in IGV position by using IGV position to effect the high-flow/low-flow determination." (*Id.* at 24-25)

109. Honeywell rejected HSC's arguments that the use of IGV position in the APS 3200 was not equivalent as "mischaracteriz[ing] the accused product." (*Id.* at 24) Honeywell further stated that HSC's argument "ignores the claim language in its analysis, its function/way/result discussion is like one hand clapping." (*Id.*)

110. In its *en banc* opinion vacating the jury verdict and remanding the case to determine if Honeywell could overcome the *Festo* presumption, the Federal Circuit recognized Honeywell's infringement position: "the function of the inlet guide vane limitation 'is to incorporate the position of the [inlet guide vanes] into the surge control system.' [Honeywell] argues that this function is met because the APS 3200 uses inlet guide vane position, in addition to temperature, to efficiently control surge." *Honeywell*, 370 F.3d at 1136-37 (citations omitted).

VIII. Prior Art Relevant To The Unforeseeability Criterion, Using The Equivalent Honeywell Presented In Connection With The February 2001 Trial

111. As set forth in Section VII above, at the February 2001 trial, in post-trial briefing, and on appeal, Honeywell argued that the equivalent to the IGV limitation was: (1) the use of a flow-related parameter in the APS 3200 that was a direct function of inlet guide vane position in the surge control system; or (2) the use of inlet guide vane position as an input to a surge control system to efficiently control surge. The following prior art relates to that equivalent.

A. Prior Art Showing The Effect Of IGV Position On A Flow-Related Parameter

112. An equivalent to the IGV limitation that Honeywell advanced at the February 2001 trial was the use of a flow related parameter that was a direct function of IGV position. At the remand trial, both technical experts – Mr. Muller and Dr. Japikse – testified that it was known in 1982 that IGV position could affect flow through the compressor. (Muller, Trial Tr. 165:1-4; Japikse, Trial Tr. 251:21-252:3) Moreover, HSC presented substantial prior art showing that IGV position affected flow through a compressor, as described below.

1. The Glennon Patent

113. U.S. Patent No. 4,164,033 patent issued in 1979 to Glennon et al. of HSC. (DX 327) Figure 1 of the Glennon patent is a compressor map, which is a well-known way of

showing flow characteristics through a compressor. There is no dispute that compressor maps were known before 1982. (Japikse, Trial Tr. 251:3-6; Muller, Trial Tr. 164:2-8; Glennon patent, DX 327, Fig. 1; Clark Dep. 67:15-20; DX 375)

114. Figure 1 of the Glennon patent shows the effect of IGV position on air flow. As the IGV position is more open, "you see higher flow levels." (Japikse, Trial Tr. 252:8-14) The Glennon patent explicitly states that "the position of its inlet guide (IGV) vanes affect the location of the operating position on the map." (DX 327, col. 2:51-53) Dr. Japikse explained that this means that "[c]hanging the guide vane position affects the location of the operating position on the map, which means different flow rates." (Japikse, Trial Tr. 252:22-253:6; *see also* Clark Dep. 439:16-24)

2. Honeywell Admissions

115. At the remand trial, Honeywell did not dispute that it was well known in 1982 that IGV position affects the air flow through a compressor. James Clark, a Honeywell engineer and Honeywell's corporate representative, testified that he has known since he started working at Honeywell in the 1970's that "if you open the inlet guide vanes more, you'll get more air flow through the compressor." (Clark Dep. 37:10-18; *see also id.* at 80:6-9, 322:13-20)

116. Because IGV position affects the flow, it necessarily affects the flow-related parameter, such as ΔP/P. Mr. Clark testified that it was known in 1982 that because a change in IGV position changes the flow, "the flow related parameter is going to change." (Clark Dep. 60:4-19)

117. Thus, Mr. Muller agreed that for "any particular pressure rise, one way to discriminate whether you are in high flow or low flow is by looking at the IGV position." (Muller, Trial Tr. 216:14-17; *see also* Japikse, Trial Tr. 257:20-22 ("IGV position [can] tell you whether you are operating in high flow or low flow."))

3. Other Prior Art

118. A number of other prior art references prior to 1982 also show the effect of IGV position on flow and flow-related parameters in a surge control system. For example, Figure 4 of the Shouman and Anderson 1964 article (DX 295) shows that "the flow level changes as we move the guide vane position." (DX 295 at Fig. 4; Japikse, Trial Tr. 255:4-14) Figure 14 of the Warnock 1976 paper (DX 305) shows different IGV settings leading to different "flow rates." (DX 305 at Fig. 14; Japikse, Trial Tr. 256:2-8)

B. Prior Art Showing IGV Position As An Input To A Surge Control System

119. On appeal from the February 2001 jury verdict, Honeywell argued to the Federal Circuit that the equivalent to the IGV Limitation was the incorporation of IGV position into the surge control system. (*See* Section VII.D, *supra*) At the remand trial, both Mr. Muller and Dr. Japikse testified that surge control systems that adjusted the set point based on IGV position were known in 1982. (Muller, Trial Tr. 166:11-17; Japikse, Trial Tr. 258:7-11) In addition, as described below, HSC presented substantial prior art showing the incorporation of IGV position into a surge control system.

1. The Glennon Patent

120. Figure 3 of the Glennon patent (DX 327) is a schematic of a surge control system that refers to the use of "inlet guide vane and/or speed information." The Glennon patent discloses the use of a signal containing "inlet guide vane" information in the surge control system (*Id.*, col. 5:33-37), and describes how "you would use an inlet guide vane input in a surge control system." (Japikse, Trial Tr. 259:10-14) Honeywell's Mr. Clark conceded that the Glennon patent "describes the use of inlet guide vane position as an input into the surge control system." (Clark Dep. 436:13-18)

2. The Warnock Reference

121. The 1976 Warnock reference (DX 305) also describes using IGV position as an input into a surge control system. (*Id.* at HSC 101032) Mr. Muller agreed that Warnock shows varying the set point in accordance with IGV position, which, as of the 1970's, was a "conventional, common way" that a surge controller works. (Muller, Trial Tr. 167:4-6, 168:11-21)

3. Honeywell Admissions

122. Mr. Muller and Mr. Clark testified that "going back to the 1970's, it was Honeywell's understanding that in order to efficiently control surge, you would need to take into account inlet guide vane angle and input into your surge control system." (Muller, Trial Tr. 168:22-169:4; Clark Dep. 365:17-22, 89:1-16).

123. Mr. Clark also explained that in Honeywell's 331-200 APU surge control system, developed in the late 1970's, "Honeywell was using inlet guide vane position as an input into the surge control system." (Clark Dep. at 308:8-11) In particular, the 331-200 contained a "schedule as a function of IGV angle of the Delta P/P" flow-related parameter. (*Id.* at 287:13-21, 321:9-16)

IX. Prior Art Relevant To The Unforeseeability Criterion, Using Honeywell's New Recharacterization Of The Equivalent On Remand

124. On remand, Honeywell has characterized the equivalent to the IGV limitation as the APS 3200's "particular use of inlet guide vanes, namely in the high-flow logic" (Honeywell Opening, Trial Tr. 27:3-6) and, more specifically, as a "surge control system that uses inlet guide vane position to compensate or correct for a flow measurement parameter that is uncertain or could have two values [i.e. the double solution characteristic]." (Muller, Trial Tr. 139:8-14; *id.* at 135:10-19 (describing the equivalent as the use of IGV position to "discriminat[e] between …

the high flow region and the low flow region of the [double-solution curve]")) As described by Honeywell in its trial brief and at trial, this recharacterization of the equivalent to the IGV limitation has three essential parts: (1) using a ΔP/P flow measurement of static pressure in the diffuser; (2) encountering the double solution characteristic; and (3) using IGV position to resolve the double solution characteristic. The following evidence relates to Honeywell's recharacterization of the equivalent.

A. Prior Art Showing ΔP/P Based On Static Pressure In Diffuser

125. The APS 3200 surge control system used as an input a measurement of static pressure in the diffuser and scroll called DELPQP. (Muller, Trial Tr. 130:25-31:10) DELPQP is an acronym that refers to the ΔP/P flow-related parameter used in the APS 3200. (Muller, Trial Tr. 169:5-21) It stands for a differential in pressure over a pressure. (Japikse, Trial Tr. 259:20-260:22; Suttie Dep. 119:13-120:20, 122:9-18) Honeywell uses similar acronyms to refer to its ΔP/P parameters. (*Id.* at 171:9-12; DX 176 at AS 146116)

126. At the remand trial, Mr. Muller and Dr. Japikse testified that the use of ΔP/P based on static pressure measurements in the diffuser was known to persons of ordinary skill in the art in 1982. (Muller, Trial Tr. 171:25-172:3, 176:4-7; Japikse, Trial Tr. 260:23-25) HSC also presented prior art compressors, including its own L1011 APU developed in the late 1960's, which utilized ΔP/P measurements in the diffuser.

1. The L1011 APU

127. Hamilton Standard, one of the predecessors of HSC, developed the APU for the Lockheed L1011 airplane in the late 1960's and early 1970's. (Brown, Trial Tr. 379:19-22) The L1011 first entered commercial service in 1972 with Eastern Airlines, and was manufactured and sold through 1983. (DX 376; Brown, Trial Tr. 380:13-14) The L1011 aircraft remains in service today. (Telakowski, Trial Tr. 428:24-429:1)

128. Richard Brown, a former Hamilton Standard engineer who worked on the L1011 APU surge control system, testified that the L1011 used a differential pressure measurement to determine when to open the surge valve. (Brown, Trial Tr. 387:14-18; Master Key, DX 105 at SUND 503: when the "differential pressure increases," it "driv[es] the surge valve toward closed") The differential pressure used in the L1011 APU was a $\Delta P/P$. (Brown, Trial Tr. 385:24-386:5; Japikse, Trial Tr. 292:8-10; Muller, Trial Tr. 146:22-147:11)

129. The L1011 surge control system was "designed to maintain minimum compressor bleed flow rate only slightly above the compressor's surge flow rate." (Brown, Trial Tr. 408:6-9)

130. The $\Delta P/P$ in the L1011 load compressor was based upon two measurements of static pressure in the diffuser: P_t and P_{s1}. (Brown, Trial Tr. 384:21-23; Master Key, DX 105 at SUND 499; L1011 Diffuser, DX 399; Muller, Trial Tr. 203:21-204:1, 204:22-24) P_{s1} is near the throat of the diffuser and P_t is near the diffuser exit. (DX 105 at SUND 493, 499)

131. P_t referenced a static pressure because near the exit of the diffuser, "static pressure and total pressure are close together." (Brown, Trial Tr. 385:9-17, 416:13-23, 417:8-12) A 1969 Hamilton Standard memo on the L1011 explains that the "static pressure measured at the downstream pressure tap on the load compressor is equal to the load compressor discharge total pressure." (PX 1066; *see generally* Clark Dep. 204:18-24: "static pressure at the far end of the diffuser" is "much closer to total pressure.")

2. The Best Patent

132. A prior art patent also disclosed using a measurement of static pressure in a diffuser in a surge control system. U.S. Patent No. 3,047,210, issued in 1962 to Best and entitled "Compressor Surge Control" (the "Best '210 patent"), explains that in a surge control system the "pressure difference between two points in the flow stream," which it labels "ΔP", may be

measured based on "the difference between entrance and exit pressures of a diffuser section." (DX 317, col. 2:42-49) Dr. Japikse explained that this shows that the measurement of pressure in a diffuser "was known and practiced and taught at the time of this document. And it's used in a flow-related parameter relationship." (Japikse, Trial Tr. 269:10-21)

3. Honeywell Admissions

133. Honeywell's technical expert Mr. Muller admitted that the "use of differential pressures and pressure, like delta P over P, regarding compressors, was known in 1982" and that "it was known in 1982 that static pressure could be used in a determination of a differential pressure such as delta P over P." (Muller, Trial Tr. 171:25-172:3, 173:9-12) An example is Honeywell's use of a ΔP/P in the APU for the F-18 fighter jet prior to 1978. (*Id.* at 172:23-173:1; DX 182)

134. Mr. Muller further admitted that there were "published reports as of 1982 showing the measurement of static pressure within diffusers." (Muller, Trial Tr. 176:4-7, 177:18-23, 178:7-10; *see* 1967 Welliver and Acurio report, DX 308 at Fig. 137; 1973 Runstadler and Dolan article, DX 288 at SUND 4862; Japikse, Trial Tr. 268:4-269:4)

135. In 1982, there were several known advantages to measuring static pressure – rather than total pressure – in the diffuser. The static pressure tap is a simple wall tap with a round hole in the diffuser, whereas a total pressure tube is stuck inside the diffuser. (Muller, Trial Tr. 182:4-8; *see also* Japikse, Trial Tr. 264:23-265:17) The total pressure tube can lead to "blockage," "some distortion of the flow field," "performance degradation" or "loss of performance," and the possibility of "physical breakoff." (Clark Dep. 96:12-97:13; *see also* Japikse, Trial Tr. 265:18-266:14) In addition, the measurement of static pressure gives a "larger Delta P," which makes the "Delta P sensor more reliable." (Clark Dep. 97:21-98:7, 99:1-5)

136. As a result, Mr. Clark testified that it was "general knowledge" dating back to at least 1976 that "if you're going to [*sic* – measure] pressure in the diffuser, you're going to want to measure static pressure." (Clark Dep. 97:15-20, 413:8-17)

137. Mr. Muller testified that the use of "static pressure measurements in a diffuser [was] not new technology" in 1982. (Muller, Trial Tr. 188:10-14) Honeywell corporate representative Mr. Clark agreed, testifying that a system Honeywell investigated in 1983 that would use ΔP/P based upon static pressures in the diffuser "doesn't require any new technology" compared to two years earlier, in 1981. (Clark Dep. 340:17-341:2, 359:4-11; DX 202)

4. ΔP/P Based On Static Pressure In The Diffuser And The Scroll

138. Honeywell contends that the measurement of static pressure in the APS 3200 was novel compared to the prior art because while the first measurement is in the diffuser throat, the second measurement is at the exit of the scroll. (Honeywell Trial Br. at 23)

139. The evidence is to the contrary. As Dr. Japikse explained: "Measuring static pressure at the throat of the diffuser and the exit of the scroll [was] known to a person of ordinary skill in the art in 1982." (Japikse, Trial Tr. 286:4-7)

140. The 1966 Perrone and Milligan report (DX 312), prepared by a predecessor to Honeywell, shows "pressure measurements at various positions from the diffuser inlet, to the diffuser exit, out to the scroll." (Muller, Trial Tr. 189:24-190:4; Japikse, Trial Tr. 285:19-286:3; DX 312 at SUND 8074, 8077)

141. The 1982 Rodgers paper (DX 282) describes as a "basic diffuser performance parameter[]" the measurement of "[d]iffuser throat – scroll exit static pressure recovery." (DX 282 at SUND 4247) This shows the pressure "at the entrance of the diffuser compared to the discharge of the scroll." (Muller, Trial Tr. 190:17-20) The "throat" of the diffuser, referenced in the Rodgers paper, is "in the diffuser." (Japikse, Trial Tr. 288:3-20)

142. U.S. Patent No. 2,470,565, issued in 1949 to Loss and entitled "Surge Preventing Device for Centrifugal Compressors," describes a surge control system that uses "differential existing between pressures." (DX 313, col. 2:40-44) Figure 1 of the Loss patent shows two taps for measuring pressure: one "at the diffuser inlet" and the second one "at the scroll or volute discharge." (Japikse, Trial Tr. 289:22-290:1; DX 313 at Fig. 1; HSC Demonstrative Ex. 15) The Loss patent "describes one pressure tap in the diffuser, a second pressure tap at the exit of the scroll, both of which are used as inputs in the surge control system." (Japikse, Trial Tr. 371:21-25)

B. Prior Art Showing The Double Solution Characteristic

143. The use of a ΔP/P in the APS 3200 based upon a measurement of static pressure at the diffuser throat and at the scroll exit led to the inverted-V or double solution characteristic. (Honeywell Trial Br. at 23-24) Mr. Muller, Mr. Clark and Dr. Japikse all testified that the existence of the double solution characteristic was known in 1982. Moreover, HSC presented evidence of prior art compressors, including its L1011 APU, which actually encountered and accounted for the double solution characteristic well before 1982.

1. The Cause Of The Double Solution Characteristic Was Known In 1982

144. The effect of a diffuser on static pressure varies, depending on the velocity of the air. With subsonic flow, the pressure in the diffuser increases from the throat of the diffuser to the discharge. However, with supersonic flow, the pressure along the diffuser decreases. (Muller, Trial Tr. 192:11-18; Clark Dep. 59:10-16; Shapiro textbook, DX 293 at SUND 6180; Japikse, Trial Tr. 271:2-23) "[I]t was known in 1982 that supersonic flow could lead to a lower pressure toward the discharge of a diffuser." (Muller, Trial Tr. 195:20-23)

145. "The high performance, high speed, centrifugal air compressors (i.e., load compressors) utilized in APUs commonly produce supersonic conditions in the diffuser (a part of the load compressor." (Muller Declaration ¶34, DX 349; Clark Dep. 116:2-6)

146. "As the velocity of the air flow reaches supersonic levels, it causes a shock wave to travel through portions of the compressor." (Muller, Trial Tr. 193:25-194:3; Clark Dep. 116:7-9; Japikse, Trial Tr. 271:3-18) The "shock wave produces large, almost instantaneous pressure changes." (Muller, Trial Tr. 194:4-6; Clark Dep. 116:10-18) The "existence of shock waves caused by supersonic flow in diffusers" was known in 1982. (Japikse, Trial Tr. 271:19-21, 272:11-16; DX 287 at SUND 3448)

147. The "inverted-V or double solution characteristic is a result of the shock wave passing by the static pressure [tap] at that point in the diffuser." (Muller, Trial Tr. 196:9-12) The "'inverted-V/double solution' characteristic is strictly a result of the location of the static pressure tap." (Muller Declaration ¶34, DX 349)

148. The flow of air through a diffuser that experiences supersonic airflow when plotted on a graph will thus show an increasing ΔP/P curve as flow increases up to the point at which supersonic flow begins, at which point the curve will turn and start decreasing with increase flow, hence the "inverted-V" shape of the curve and the possibility of a double value for a particular ΔP/P. (Muller, Trial Tr. 133:19-134:6); *see also Honeywell*, 370 F.3d at 1136 n.1.

149. Mr. Muller averred in a declaration submitted in this case that it was known that "[a]ny compressor taking a static pressure measurement of supersonic air flow in the diffuser would have [an inverted-V] characteristic." (Muller Declaration ¶34, DX 349) And both of those predicates were known in 1982: that "you could measure static pressure in the diffuser" and that "supersonic flow could pass through diffusers." (Muller, Trial Tr. 199:1-9)

150. Honeywell's corporate representative Mr. Clark agreed that "any time that you take a static pressure measurement in the context of a flow parameter within the diffuser that experiences supersonic flow, you're going to expect to see that double solution curve." (Clark Dep. 127:3-7; *see also id.* at 135:3-7)

151. Mr. Clark further conceded that he knew and understood the "fluid dynamic principles behind the double solution problem" – "shockwaves and pressure drops" – since he was in college in the late 1960's and early 1970's. (Clark Dep. 117:25-118:12) Richard Brown, a Hamilton Standard engineer who worked on the L1011 APU, learned of the principles "underlying the effect of supersonic flow on static pressure" in his studies in the 1950's. (Brown, Trial Tr. 388:22-389:6)

152. When the first measurement of static pressure is in the diffuser throat, the tendency to see the inverted-V or double solution characteristic is not affected by "whether the second measurement is at the exit pressure of the scroll as opposed to the exit of the diffuser." (Japikse, Trial Tr. 290:5-10) You "just have to have the two pressure taps on the two sides of the shock, one upstream of the shock and one downstream. And you will have it either way." (Japikse, Trial Tr. 290:11-14) The only place that the shockwave from supersonic flow will occur is in the diffuser. (Clark Dep. 118:23-119:6)

2. The L1011 APU Encountered the Double Solution Characteristic

153. As described above (IX.A.1, *supra*), the L1011 APU measured flow using static pressure taps in the diffuser. By the early 1970's, HSC engineers recognized that the L1011 APU was encountering the double solution curve. (Brown, Trial Tr. 389:7-391:17)

154. The Master Key document for the L1011 APU explained that with ***subsonic*** flow, "there is a progressive ***pressure rise*** from P_{S0} to P_T" but if "flow becomes ***supersonic*** … there is a progressive ***pressure loss*** from P_{S0} to P_T." (DX 105 at SUND 499; emphasis added)

155. This pattern of pressure rise at subsonic flows and pressure loss at supersonic flows is the cause of the double solution problem. (Japikse, Trial Tr. 273:25-279:23). This pattern was well established in standard reference books decades before 1982, including the SAE Aerospace Handbook (DX 290), the Creare Diffuser Data Book (DX 287), and the Shapiro textbook (DX 293). (*Id.*; Japikse, Trial Tr. 270:2-273:24)

156. In 1971, Hamilton Standard found that the surge valve could erroneously open to exhaust even though flow was high. (Brown, Trial Tr. 389:7-390:14) Hamilton Standard plotted the data and saw that there was a "double valued function": "you get the same delta P over P for widely different flows." (Brown, Trial Tr. 389:23-392:17; HSC Demonstrative Ex. 18) Mr. Brown saw this double valued function on the L1011 load compressor as operated in 1971. (*Id.*)

157. An October 28, 1975 Hamilton Standard memo investigating a potential change in the L1011 surge control system referred to how the potential new system "does not reverse at high load compressor flow conditions as the diffuser pipe signal does to erroneously open the surge valve." (DX 108 at SUND 674) It also refers to the "tendency of both the signal curve and the ΔP curve to peak and then drop off thus potentially giving an ambiguous signal." (DX 108 at SUND 677) Both of these references are to the "double value function" that Hamilton Standard first observed in 1971. (Brown, Trial Tr. 395:3-25)

158. A May 30, 1975 Hamilton Standard memo contained a number of figures relating to the L1011 APU. (DX 104) Six of those figures are discussed in the text and thirteen are not. (*Id.*) Figure 9 contains a graph of ΔP/P (left axis) versus corrected flow. (*Id.* at SUND 294) This double value curve is "essentially" what Mr. Brown saw in his work in 1971, as Mr. Brown drew in HSC Demonstrative Exhibit 18. (Brown, Trial Tr. 398:12-19) The corrected

flow numbers at the bottom of Figure 9 of DX 104 accurately reflect the actual corrected flow of the L1011 APU. (Brown, Trial Tr. 398:24-399:2)

159. The $\Delta P/P$ in Figure 9 is labeled as $P_{G3} - P_{G2}/P_{G3}$. These are the "same pressures with different labels" as $P_t - P_{s1}/P_t$, found in the Master Key document (Brown, Trial Tr. 398:9-11, 410:19-22, 415:23-416:23)

160. To address the double value function, the L1011 APU incorporated a shock switch, which "overrides the surge value control driving the surge valve toward full closed" when supersonic flow is sensed. (DX 105 at SUND 505; Brown, Trial Tr. 400:24-401:6; Japikse, Trial Tr. 294:8-9) The shock switch did not prevent the L1011 APU from operating in supersonic flow, but instead "prevented the surge valve from opening improperly" by ignoring the differential pressure signal when flow was supersonic. (Brown, Trial Tr. 401:14-18; Japikse, Trial Tr. 294:19-295:3)

161. The shock switch was implemented in 1972. (Brown, Trial Tr. 414:10-12; DX 109 at SUND 780)

3. HSC Did Not "Abandon" The L1011 APU Surge Control System

162. Honeywell argues that HSC "abandoned" its surge control system. (Muller, Trial Tr. 154:2-12) The evidence at trial disproved this argument.

163. In 1975, Hamilton Standard looked at the possibility of replacing the static pressure taps with a boosted pitot. (DX 104) However, as a result of disadvantages of the boosted pitot tube (including the possibility of getting "clogged," and the blocking of flow), Hamilton Standard decided to continue to use the static pressure taps and not to use the boosted pitot tube. (Brown, Trial Tr. 414:24-415:16)

164. In 1980, Hamilton Standard created approximately 15 APUs with an "alternate" high pressure configuration for one customer, Air Canada. (PX 1067; JX 42 at SUND 2671;

Telakowski, Trial Tr. 424:13-23, 425:24-426:5, 428:2-5) However, Hamilton Standard did not "abandon its baseline L1011 surge control system" when it produced this alternate configuration. (*Id.* at 425:10-12) Hamilton Standard did not "change the design of the baseline L1011 APU" and "continued to manufacture" the baseline APU. (*Id.* at 426:6-12) And it later converted the "alternate" configuration APUs back to the baseline or original design. (*Id.* at 428:17-23)

4. Other Prior Art

165. HSC introduced several examples from the literature in 1982 or earlier of the double solution characteristic. (Japikse, Trial Tr. 280:3-5) For instance, a 1977 article by Baghdadi (DX 217) shows an "inverted-V/double solution" curve in Figure 12. (DX 217 at Fig. 12; Japikse, Trial Tr. 281:4-11) A 1970 Dean, Wright and Runstadler report that Japikse used at Concepts NREC beginning in 1980 shows "another inverted-V type of curve" in Figure 178. (DX 229 at Fig. 178; Japikse, Trial Tr. 281:12-282:3)

166. In fact, Mr. Muller was aware that "double solution behavior" could occur during his personal work on compressor operations. (Muller, Trial Tr. 199:10-13)

C. Use Of IGV Position To Address The Double-Solution Characteristic

167. Several of Honeywell's APUs have an "inverted-V/double solution" issue similar to that encountered by the APS 3200 APU. (Clark Decl. ¶10, DX 350)

168. In the late 1980's, Honeywell developed the 331-350 APU. The surge control system in Honeywell's 331-350 APU (developed for the A330 airplane) used a $\Delta P/P$ parameter based upon a measurement of static pressure in the diffuser and a measurement of total pressure in the scroll discharge. (Clark Dep. 135:16-19; DX 214 at RMD 482, attached as Exhibit A; Japikse, Trial Tr. 300:10-12)

169. As a result, the 331-350 APU "has the same inverted V or double solution problem as the APS 3200." (Clark Dep. 189:11-14; *see also id.* at 383:20-22; DX 210; Japikse, Trial Tr. 300:13-20)

170. Honeywell addressed this issue by using " inlet guide vane position in order to recognize whether you're experiencing the double solution problem." (Clark Dep. 131:16-19; Japikse, Trial Tr. 300:21-23) Specifically, the 331-350 APU used IGV position as an input in determining "whether to override the surge control system" if you are on the "high flow area of the double solution curve." (Clark Dep. 384:3-10; *see id.* at 134:8-15)

171. Honeywell used IGV position to address the double solution characteristic because "IGV position" "changes the compressor map." (Clark Dep. 141:9-15)

172. As of 1982, the use of IGV position (as shown in a typical compressor map) was a known way to determine whether flow is low or high. (Japikse, Trial Tr. 298:7-17) "For any particular pressure rise, one way to discriminate between whether you are in high flow or low flow is by looking at the IGV position." (Muller, Trial Tr. 216:14-17; Japikse, Trial Tr. 299:13-16)

173. Honeywell's corporate representative testified that had the double-solution problem encountered by Honeywell's APU come up in the 1970's, Honeywell would have used the same solution using IGV position:

> Q: In the late 1970's, had the double solution problem come up, it could have been solved at Honeywell?
>
> A: If it had come up – if it had come up it could have been solved.
>
> Q: And it could have been solved by using the inlet guide vane position, correct, in the late 1970's?
>
> A: The same way we did it on the 350.

(Clark Dep. 162:3-14; *see also id.* at 131:16-19 (testifying that in the 331-350 APU, Honeywell resolved the "double solution" curve by using "inlet guide vane position in order to recognize whether you're experiencing the double solution problem"))

CONCLUSIONS OF LAW

I. The *Festo* Presumption Of Prosecution History Estoppel

174. The sole issue on remand is whether Honeywell can overcome the presumption set forth in *Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.*, 535 U.S. 722 (2002), that it surrendered all equivalents to the inlet guide vane limitation when it narrowed its patent claims through amendment in order to overcome the examiner's prior art rejection and gain allowance. *Honeywell,* 370 F.3d at 1144.

175. It is Honeywell's burden to overcome the *Festo* presumption. *Festo*, 535 U.S. at 740. Honeywell "must show that at the time of the amendment one skilled in the art could not reasonably be expected to have drafted a claim that would have literally encompassed the alleged equivalent." *Id.* at 741.

176. To overcome the presumption, Honeywell must show that: (1) "the alleged equivalent would have been unforeseeable at the time of the narrowing amendment"; (2) "the rationale underlying the narrowing amendment bore no more than a tangential relation to the equivalent in question"; or (3) there was "'some other reason'" suggesting that Honeywell "could not reasonably have been expected to have described the alleged equivalent." *Festo*, 344 F.3d at 1368.

177. Whether Honeywell can overcome the presumption of prosecution history estoppel is a question of law to be decided by the Court. *Festo*, 344 F.3d at 1367-68; *Biagro*, 423 F.3d at 1301-02.

178. In *Festo*, the Supreme Court held that "[a] patentee's decision to narrow his claims through amendment may be presumed to be a general disclaimer of the territory between the original claim and the amended claim." 535 U.S. at 740.

179. The Supreme Court noted that this rule was consistent with the Court's precedent and the reasonable expectations of patentees. "Therefore, the Court held, 'when the patentee has chosen to narrow a claim, courts may presume the amended text was composed with awareness of this rule and that the territory surrendered is not an equivalent of the territory claimed.'" *Honeywell*, 2006 U.S. Dist. LEXIS 11829, at *6 (quoting *Festo*, 535 U.S. at 741).

180. In remanding this case, the Federal Circuit held that Honeywell's "rewriting the dependent claims into independent form, along with canceling the original independent claims constitutes a narrowing amendment." *Honeywell*, 370 F.3d at 1141. Accordingly, the Federal Circuit held that Honeywell's amendments created prosecution history estoppel and that accordingly "there is a presumptive surrender of all equivalents to the inlet guide vane limitation." *Id.* at 1144.

181. The Federal Circuit held:

> The only independent claims asserted in this case, claims 4, 8 and 19, were originally dependent on independent application claims 16, 32, 48 and 49, which did not include the inlet guide vane limitation. Claims 4, 8 and 19 included the inlet guide vane limitation. Claims 4, 8 and 19 were rewritten into independent form, and the original independent claims were cancelled, effectively adding the inlet guide vane limitation to the claimed invention. Honeywell is presumptively estopped from recapturing equivalents to the inlet guide vane limitation.

Id. In other words, Honeywell's "decision to narrow [its] claims through amendment [is] presumed to be a general disclaimer of the territory between the original claim and the amended claim." *Festo*, 535 U.S. at 740.

182. These legal determinations by the Federal Circuit govern this remand. *Honeywell*, 370 F.3d at 1144.

183. Accordingly, this Court's previous denial of HSC's motion for summary judgment based upon prosecution history estoppel (*Honeywell*, 2001 U.S. Dist. LEXIS 2155) does not bear on the outcome of this remand. *See Porter v. Farmers Supply Service, Inc.*, 617 F. Supp. 1175, 1180 (D. Del. 1985) (courts do not make disputed factual findings on motion for summary judgment).

184. Moreover, the Court's statement in its summary judgment opinion – that "Honeywell did not give up an embodiment of the invention with the inlet guide vane" (*Honeywell*, 2001 U.S. Dist. LEXIS 2155, at *19-20) – is not inconsistent with holding on remand that Honeywell did not overcome the *Festo* presumption that it surrendered *all equivalents to* the inlet guide vane limitation, and therefore that Honeywell is estopped from recapturing *all equivalents to* the inlet guide vane limitation. In addition, to the extent Honeywell reads the Court's decision denying summary judgment as finding that Honeywell did not surrender *all equivalents to* the inlet guide vane limitation, the Federal Circuit subsequently decided that issue and expressly held that "there is a presumptive surrender of all equivalents to the inlet guide vane limitation," and that "Honeywell is presumptively estopped from recapturing equivalents to the inlet guide vane limitation." *Honeywell*, 370 F.3d at 1144. Thus, the Court's previous denial of summary judgment does not inform the outcome of this remand proceeding.

II. Honeywell Failed To Establish That It Could Not Have Drafted A Claim That Would Have Literally Encompassed The Alleged Equivalent

185. The overarching question the Supreme Court raised in *Festo* is whether Honeywell can show "that at the time of the amendment one skilled in the art could not reasonably be expected to have drafted a claim that would have literally encompassed the alleged

equivalent." *Festo*, 535 U.S. at 741; *Honeywell*, 2006 U.S. Dist. LEXIS 11829, at *6 (quoting *Festo*, 535 U.S. at 741). This test guides the analysis under the three *Festo* criteria.

186. Here, Honeywell has not established any reason that it could not have drafted a claim that would have literally encompassed the alleged equivalent to the IGV limitation when it amended the asserted claims in 1982-1983.

187. When the examiner rejected Honeywell's original independent claims as obvious during prosecution, Honeywell had a choice. Honeywell could have: (1) challenged (or "traversed") the examiner's rejection, and if necessary, appealed the examiner's decision; (2) drafted a claim of intermediate scope that covered subject matter in between the original rejected independent claim and the narrower claim that was allowed; or (3) acquiesced to the examiner's allowance of the original dependant claims which literally required the specific use of inlet guide vane position that Honeywell concedes the accused APS 3200 does not use. Honeywell chose option number 3 – to accept the examiner's offer to allow the original dependent claims, if rewritten in independent form, without further amendment, without challenging the examiner's rejection, without appeal and without drafting any alternative claims.

188. Honeywell did not put forth any reason that upon rejection of the original claims it could not have drafted a claim of intermediate scope – narrower than the rejected independent claims but broader than its original dependent claims – that literally encompassed the alleged equivalent. While the Court authorized Honeywell to introduce fact testimony from Richard Konneker, Honeywell's former in-house patent lawyer responsible for prosecuting the patents-in-suit, regarding why Honeywell "'could not reasonably be expected to have drafted a claim that would have literally encompassed the alleged equivalent,'" Honeywell elected not to call Mr. Konneker. *Honeywell*, 2006 U.S. Dist. LEXIS 11829, at *14-15.

189. Thus, Honeywell did not establish any reason that it could not have drafted an intermediate claim directed at a broader use of IGV position in a surge control system, not limited to the specific use of IGV position the issued claims require. Nor is there any evidence of anything that would have prevented Honeywell from drafting such a claim. Honeywell introduced no evidence at all as to why it "*could* not (as opposed to *would* not) have drafted the claims to encompass the equivalent." *Id.* at 15 (emphasis in original). Honeywell simply chose not to draft such a claim, and instead accepted the narrower description of its invention and the estoppel that came with it.

190. Under similar facts, courts have determined that the patentee could not overcome the *Festo* presumption. In *Festo* itself, for example, Festo could not overcome the presumption because it "could have described the accused equivalent at various levels of specificity by using a common descriptive term such as 'aluminum' or 'metal'" instead of limiting the claim to "magnetizable." 344 F.3d at 1372.

191. Similarly, in *Windbrella v. Taylor Made Golf*, the patentee could not overcome the presumption because "Windbrella had the option, after claim one was rejected, to contest the patent examiner's advice and amend the claim differently, to pursue a broader patent specification. Instead, it accepted a narrower description of the latch." 414 F. Supp. 2d 305, 319 (S.D.N.Y. 2006).

192. For this reason alone, Honeywell has not met its burden to overcome the *Festo* presumption.

III. The Alleged Equivalent Was Not "Unforeseeable"

193. Honeywell has not met its burden of establishing that the alleged equivalent to the IGV limitation was unforeseeable at the time of the narrowing amendments.